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Change in the relationship between drinking alcohol and risk of violence among adolescents and young adults: A nationally representative longitudinal study

Running Title

Alcohol and violence

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Keywords

Violence, alcohol, epidemiology, adolescence, gender

Abstract

Aims: To quantify the relationship between alcohol and violence with increasing age.

Methods: Data were from The National Longitudinal Study of Adolescent to Adult Health (ADD Health) of 20,386 people representative of the US population. Mean age at the first wave of interviews was 16.2 years, with subsequent interviews mean of 1, 6.3 and 12.9 years later. We used randomised effects models and predictive marginal effects of the association between varying quantities of alcohol consumption and violence while controlling for possible confounders

Results: Violence was reported by 19.1% of participants at wave I, but just 2.1% at wave IV. The random-effects model showed that consuming 1-4 drinks on each occasion was associated with a modest increase in risk of violence in males and females (OR 1.36 (1.13-1.63) and 1.33 (1.03-1.72) respectively). For consumption of 5 or more drinks on each occasion the risk remained similar for females (OR 1.40 (0.99-1.97)), but increased considerably for males (OR 2.41 (1.96-2.95)). Predictive marginal effects models confirmed that violence rates decreased with age.

Conclusions: Alcohol is most strongly linked to violence among adolescents, so programmes for primary prevention of alcohol-related violence are best targeted towards this age group, and particularly males who engage in heavy episodic drinking.

Short Summary

We have analysed data from a large longitudinal, nationally representative sample to investigate the longitudinal relationship between alcohol and violence.

We found that alcohol is more strongly linked to violence among adolescents than in adults, and particularly males rather than females who engage in heavy episodic drinking.

Introduction

Violence is responsible for high global rates of morbidity and mortality, with homicide representing the 4th leading cause of death for 15-29 year olds (World Health Organisation, 2010). Rates of criminal injury that require hospital treatment are 30-40 times higher among this age group (World Health Organisation, 2005). The direct and indirect costs to the individual and society are high (Organization, 2008), with the economic burden of violence estimated to be approximately 3% of GDP in both the USA (World Health Organisation, 2004) and the UK (Dubourg et al., 2005) annually.

Although the causes of violence are complex and multifactorial, one of the most common risk factors for violent behaviour is alcohol use. Violence is commonly carried out by people who had consumed alcohol prior to the offence (CSEW, 2013), and about half of victims of assault believe that their attacker was under the influence of alcohol at the time of the assault (Steen and Hunskaar, 2004).

It is known that alcohol consumption in Western countries tends to increase markedly from adolescence into adulthood. In the USA, around 4% of 12-14 year olds report drinking in the last month (Health and Social Care Information Centre, 2014), while 20% of 12-20 year olds, and up to 56% of those aged over 20 report drinking alcohol (Substance Abuse and Mental Health Services Administration (SAMHSA), 2015b). The rate of heavy episodic drinking (often defined as 5 or more drinks for men and 4 or more drinks for women on a single drinking occasion (Wechsler and Nelson, 2001)) also rises sharply during early adulthood from 5.8% of 12-17 year olds to approximately 38% of 18-34 year olds (Substance Abuse and Mental Health Services Administration (SAMHSA), 2015a). In contrast however, rates of violence in the general population tend to peak in adolescence and decline thereafter (Flatley et al., 2010; Nash and Kim, 2006). Thus, although a common explanation for violence is alcohol consumption, rates of alcohol consumption rises while rates of violence fall in the general population in Western countries during the period from adolescence to adulthood.

Several longitudinal studies have found evidence for a relationship between alcohol and violence. Two studies that used data from the Longitudinal Study of Adolescent

Health (Add Health) found evidence of a significant relationship between alcohol and violence. Using data from waves I and II among a subgroup of adolescents who reported drinking alcohol, the initiation of violence was associated with high volume or frequent alcohol use (Swahn and Donovan, 2004, 2005). Similarly, an analysis of data from the Christchurch birth cohort found a significant relationship between alcohol and violence in 15-21 year olds after adjusting for a wide range of covariates (Boden et al., 2012; Fergusson and Horwood, 2000). Other longitudinal studies have similarly found a positive relationship between alcohol and violence (Blitstein et al., 2005; Duncan et al., 1997; Ellickson et al., 2003; Xue et al., 2009).

Several longitudinal studies however have found a positive relationship between alcohol and violence at some time points and not others. A latent class analysis of the Christchurch data (Wells et al., 2004) identified 4 latent classes, representing increasing levels of severity of alcohol problems. The severity of alcohol problems predicted violence at age 16-21, but not at age 21-25. Two papers arising from the Pittsburgh Youth Study reached differing conclusions. Data from 506 boys aged 13 who were interviewed annually until age 18 showed significant association between alcohol at age 13, and violence at any time between age 14 and 18 (White et al., 1999). However in a subsequent analysis, the relationship between alcohol use at each age and violence the following year was significant only among those drinking at age 13 (Wei et al., 2004). In a study from Australia, (Scholes-Balog et al., 2013), alcohol consumption at age 13 was found to be associated with violence at age 15, however alcohol consumption at age 15 was not associated with violence at age 17. Another study which involved structural equation analysis of over 808 students over 4 waves found only weak evidence of a relationship between alcohol and aggression in one out of the three paths tested (Huang et al., 2001).

There are several reasons why some studies and not others have found a significant relationship between alcohol and violence. First, the age of the participants both at inception and at follow up varies between the studies. Some studies recruited children aged 10 or younger, while others recruited older children and young adults. The age at which violence was measured as the outcome variable also varied considerably between studies, while some investigated overall trajectories of violence. It is possible therefore that the relationship between alcohol and violence is not

constant, and may vary with age. Second, many studies have not controlled for the breadth of potentially relevant confounders, or have studied highly selected groups such as from schools in high crime areas. Third, many studies have been relatively small (less than 500 participants) and few have included a comprehensive set of variables that have been identified as being associated with both violence and alcohol use. Finally, few studies have incorporated changes in level of alcohol use during the course of the study, and have relied on baseline alcohol use and subsequent violence.

Our aim was therefore to examine whether the risk of violence associated with alcohol use varies by age, in a large nationally representative cohort of adolescents, over a 13 year period, while adjusting for potential confounders. Our null hypothesis was that there was no change in the relationship between alcohol and violence with increasing age.

Methods

Design and setting

We used data from the National Longitudinal Study of Adolescent Health (Add Health (Harris et al., 2009), a study of nationally representative adolescents in the United States of America (USA), which commenced in 1994-95. Interviews took place in four waves which were carried out in 1994/5, 1995/6, 2001/2 and 2007/8. At baseline (wave I), the participants were between age 11 and 21 (mean age 16). Participants were selected from 80 high schools and 52 middle schools in numbers proportional to the size of each school. The design also ensured that the sample was representative of US school attenders with respect to country of origin, school size, school type, urbanicity, and ethnicity(Harris, 1995).

Participants were interviewed in their homes using audio-computer assisted self interview (ACASI). A parent of each participant also completed an interviewer-assisted questionnaire at wave I. Nationally collected social, demographic, and criminological data from the US Census Bureau at the level of census block group (consisting on average of 452 housing units or 1,100 people (1990) were linked to participants in the study for use as covariates in the analyses. Participants were interviewed on three further occasions, (wave II in 1996, wave III in 2001/2002, and wave IV in 2008).

Exposure Data

At each of the four waves, participants were asked the same two questions about their alcohol exposure: *“Think of all the times you have had a drink during the past 12 months. How many did you usually have each time? - A ‘drink’ is a glass of wine, a can of beer, wine cooler, a shot glass of liquor, or a mixed drink.”* Responses were categorised as 0, 1-4 and 5 or more. *Participants were also asked, “Over the past 12 months on how many days did you drink 5 or more drinks in a row?”* Responses were: *“1 or 2 days”, “Once a month”, “2 or 3 days month”, “1 or 2 days a week”, “3 to 5 days a week” or “Every/almost every day”.*

Outcome variables

Violence

Violence was ascertained at each of the 4 waves by asking, *“In the past 12 months, how often did you hurt someone badly enough to need bandages or care from a doctor or nurse?”* Participants responded either “Never”, “1 or 2 times”, “3 or 4 times”, or “5 or more times”, and responses were converted to a binary variable for this study to indicate whether or not they reported engaging in violence. Two secondary outcome measures were also examined –the frequency of physical fighting “physical fighting” (asked at wave I, II and IV), and whether the respondent had been involved with fighting in a group against another group, “group fighting” (asked at all 4 waves).

Co-variates

Individual-level time-variant covariates which were gathered by self-reported questionnaires at every wave were cigarette smoking (which we categorised as 0, 1-60 and 60 or more cigarettes per month), cannabis use (used versus not used cannabis in the past 12 months), and age. Covariates analysed as time-invariant were gathered at wave I, which were ethnicity (categorised as White, Black, Asian or other), gender (male or female), IQ (measured using The Adolescent Health Picture Vocabulary Test adapted from the Peabody Picture Vocabulary Test, Revised (Dunn and Dunn, 1981)), temper (parent report as to whether the child has a bad temper (“Yes/No”)), depression (measured on a 19-item scale at wave I adapted from the Center for Epidemiologic Studies of Depression Scale (CES-D) (Radloff, 1977)), parental conflict (parent report as to how much they “fight or argue” with their spouse, on a scale 0-3, those without a spouse were coded as 0), peer substance abuse (of their three closest friends, how many who drink alcohol, smoke cigarettes or use marijuana at least once a month, total score 0-9), and delinquency (sum of 11 questions regarding frequency of behaviours including stealing, damage to property, entering buildings without permission, running away and selling drugs).

We used two neighbourhood measures, assumed to be time-invariant, measured at wave I, which were neighbourhood disadvantage, and neighbourhood violent crime rate. Neighbourhood disadvantage is a composite variable derived from US Census Bureau statistics comprised of: (a) proportion of single parent families, (b) proportion

of households with income less than \$15,000; (c) proportion of people with high school diploma; and (d) unemployment in the neighbourhood in which each participant was located, defined as a US Census Bureau census block group which had, on average, 452 housing units or 1100 people. We used principal component factor analysis to obtain the composite neighbourhood disadvantage variable. The variables loaded strongly onto a single factor, with loadings of 0.76, 0.88, 0.81 and 0.83 for the proportion of single parent families, proportion of households with income less than \$15,000, proportion of people with high school diploma; and unemployment respectively.

Statistical analysis

We first fitted random effects models using the entire cohort to investigate the effect of levels of exposure to alcohol on violence over the 4 waves. We estimated the marginal effect using the delta method (the difference in probability of the outcome when the exposure is present versus not present) for ages between 12 and 30 years by gender. We then repeated the analysis on an incident violence cohort, in which all those who reported violence at wave I were excluded in order to further investigate causality. Stata 12 was used for all analyses (StataCorp, 2012).

For calculations of proportions of those violent we present in tables, we used inverse probability weighting (IPW) to take into account the sampling design and non-response at preceding waves.

Sensitivity analyses

We carried out 2 sensitivity analyses. First, it could be considered that delinquency is on the causal pathway between alcohol and violence, and therefore adjusting for it may have introduced bias, and reduced the estimate of the effect size. We therefore repeated the analyses excluding delinquency as a co-variate. Secondly, we used alternative measures of violence as the outcome measure (serious fighting, and fighting in a group).

Results

There were 20,542 individual at wave I, 49.4% were males. The mean age was 16.2 (sd=1.71, range 11.4-21.4). There were 14,712 individual at wave II (48.7% males,

mean age 16.7, sd=1.61), 14,948 at wave III (47.1% males, mean age 22.5, sd=1.75), and 15,699 at wave IV (46.8% males, mean age 30.0, sd=1.75).

Alcohol use

Table 1 shows the characteristics of the participants by alcohol use at wave 1), with frequencies and weighted proportions of those endorsing each response used in calculating associations between alcohol use and violence.

Table 1 about here

Violence

The weighted proportion of people reporting violence at wave I was 19.1% . At wave II, the weighted proportion was just over 8%, and was 6.4% at waves III and 2.1% at wave IV.

Relationships between alcohol consumption and violence

The random-effects model of the effect of change in alcohol exposure on violence, while adjusting simultaneously for time-variant and time-invariant confounders showed that, overall, drinking 1-4 drinks on each occasion was associated with an increase in risk of violence in males and females (OR 1.36 and 1.33 respectively) (see table 2). Heavier drinking, (more than 5 drinks on each occasion) was associated with a further increase in the odds of violence among males (OR 2.41, 95% CI 1.96-2.95, $p<0.001$) compared with non-drinkers, whilst the elevation remained similar for females (OR 1.40, 95% CI 0.99-1.97, $p=0.055$).

Table 2 about here

Figure 1 shows the predictive marginal effect of alcohol (plotted by categories of no alcohol, 1-4 drinks and 5 or more) on the probability of violence from age 12-30 for males and females separately. The probability of violence is greater in males than in females, however the pattern is similar in both sexes; drinking 5 or more drinks each

occasion is associated with a higher probability of violence from age 12, continuing into mid 20s and beyond, whereas consuming 1-4 drinks is not associated with a significantly higher probability of violence compared with non-drinkers.

Drinking 1-4 drinks or 5 or more drinks on each occasion is associated with a significantly higher probability of violence between age 12 and approximately age 18. Thereafter, there is no additional risk of violence among those who drank 1-4 drinks each occasion compared with those who drank no alcohol in either gender. Those who reported usually having 5 or more drinks on a single occasion had a significantly higher probability of violence than non-drinkers throughout the period of observation, but the trajectories tended to converge with increasing age, and more so for females than males.

Figure 1 about here

Sensitivity analyses

We carried out a repeat of the analyses without adjustment for delinquency as it is possible that adjusting for delinquency may have reduced the estimate of the effect size if it is on the causal pathway between alcohol and violence. The association between heavy drinking (drinking 5 or more drinks) and violence remained almost the same in these analyses both for males (OR 2.24, 1.93-2.61, $p < 0.001$), and females (OR 1.64, 1.30-2.07, $p < 0.001$). However, the model with no adjustment for delinquency did show evidence for association between drinking 1-4 drinks and violence in males (OR 1.32, 1.14-1.51, $p < 0.001$) and females (OR 1.41, 1.17-1.69, $p < 0.001$).

We also investigated other categories of violence, namely physical fighting and fighting in a group. Similar findings were found for at least one reported episode of physical fighting. Among men, drinking between 1-4 drinks was associated with such violence (OR 1.28, 1.09-1.51, $p = 0.003$), as was consuming 5 or more drinks (OR 1.91, 1.57-2.33, $p < 0.003$). Among females, 5 or more drinks was associated with violence (OR 1.36, 1.03-1.79, $p = 0.028$) but consuming 1-4 drinks was not (OR 1.15, 0.94-1.41, $p = 0.163$). Rates of self-reported fighting in a group were also higher at any level of

reported drinking in both sexes. Males who consumed 1-4 drinks had increased rates of violence (OR= 1.89 (1.59-2.25, $p<0.001$), as did males who consumed 5 or more drinks had OR= 3.0 (2.46-3.65, $p<0.001$). Females who consumed 1-4 drinks also had increased rates of violence (OR 1.5, 1.24-1.89, $p<0.001$), as did females who consumed 5 or more drinks (OR 1.81, 1.38-2.39, $p<0.001$).

Discussion

We carried out a longitudinal study of nationally representative adolescents and young adults to investigate the dynamic association between alcohol and violence while controlling for a comprehensive set of individual and social-contextual confounders. We found that those who consumed, 1-4 drinks each occasion had a 36% higher risk of violence, and those who consumed 5 or more drinks had 214% higher risk compared with those who did not drink alcohol. Moreover, we found that both violence rates and the effect of alcohol on violence apparently diminished with increasing age in both males and females. Those who drank 1-4 drinks had an elevated risk of violence only during adolescence (not adulthood) compared with those who did not drink. Furthermore, for those who drank 5 or more drinks each occasion, the risk was apparently highest amongst adolescents, but the relative risk gradually reduced and seemed to converge by the 4th decade. Similar patterns were found for both males and females. This finding was confirmed when other measures of violence (serious physical fighting and fighting in a group) were examined, however, there were differences in the association between alcohol and fighting in a group. The effect of heavy drinking on fighting in a group was greater than for non-group fighting, and this effect, continued to be evident until the 4th decade.

Overall, the prevalence of alcohol use and misuse in this study is similar to that found in other national surveys in the USA (Chen et al., 2013). Our findings are also consistent with the studies suggesting that the association between alcohol and violence is present only in younger cohorts (Wells et al., 2004) (Scholes-Balog et al., 2013).

Confounding

The association between alcohol use and violence was adjusted for several factors that were, *a priori*, known to be associated with alcohol misuse and violence. An extensive set of factors including individual, family, and neighbourhood characteristics were adjusted for. An additional strength was the ability to control for official rates of violent crime in the local community, as well as official indicators of deprivation. Two variables were responsible for large confounding effects; they were peer drug use, and delinquency which both reduced the apparent association by over 70% in preliminary univariate analyses. It is possible that violence and substance misuse are part of a problem behaviour syndrome, and that each of these behaviours may be expressions of a common underlying phenotype, however, there is some prior evidence that a single common factor cannot adequately explain both substance use and delinquency (LeBlanc and Loeber, 1998; Osgood et al., 1988; Paradise and Cauce, 2003; Tremblay et al., 2004; White and Labouvie, 1994). That there remained a significant association between alcohol and violence even after controlling for other substances as well as non-violent delinquency indicates that an underlying propensity for risk-taking, addictive or general problem behaviours does not adequately explain the observed association between alcohol and violence in this study.

Association with drug using peers also explained a large proportion of the apparent relationship, indicating that young people who drank and who were violent were significantly more likely to associate with substance using peers. It is possible that some of the violence occurred because violent provocation may be more likely to occur among peer groups whose members become intoxicated, disinhibited or are in states of withdrawal, or who use violence in the acquisition of substances or the means to acquire them. The association remained significant between alcohol and violence even after controlling for peer substance use in our study. Adjustment for gender, ethnicity, IQ, depression, temper, neighbourhood violent crime and neighbourhood disadvantage resulted in small changes in the crude relationship. Although a fairly comprehensive set of potential confounders were selected, the list was not exhaustive and there are other potential confounders that were not used in this analysis.

Causality

Although we have found a relationship between alcohol and violence, we are unable to ascertain whether this is a causal relationship. We consider causality with respect to the Bradford-Hill criteria (Bradford-Hill, 1965).

Temporality. In this study, the measurement of alcohol use preceded the observation of violence by virtue of the prospective longitudinal design and the use of statistical methods appropriate to the design. Given that questions relating to the exposure and outcome were ascertained repeatedly over 4 waves, there are multiple opportunities to assess the temporal relationship within individuals, however there remains a difficulty in ascertaining the temporal sequence of alcohol and violence when both arise between waves of data collection as would have happened with some individuals in this study. *Dose-response relationship and strength of association.* Analysis of the entire cohort showed that those who regularly consumed 1-4 alcoholic drinks had an increased odds of violence of 1.36 and those who regularly drank 5 or more drinks on each occasion the odds of violence was 2.4. Using the method described by Chen (Chen et al., 2010) odds ratios of 1.7, 3.5 and 6.7 are estimated to be equivalent to Cohen's d effect sizes of small, medium and large respectively. We observed some evidence of a dose-response effect, however the observed association between alcohol consumption and later violence in our study is overall small.

Consistency A causal interpretation is strengthened when the association is consistently found after multiple replications. In our study, we found the association held across several different measures of violence, including measures of violence, fighting, and group violence. *Biological Plausibility* There is evidence from previous research that alcohol has differential effects on the adolescent compared with the adult brain; for example adolescents have more memory impairment during acute intoxication than adults (Acheson et al., 1998). It is possible therefore that younger people are more susceptible to the detrimental effects of alcohol. Adolescence is a time of major development of the human brain, and particularly of the prefrontal cortex that is important for impulse control, and this be a factor contributing towards adolescents' propensity for risk-taking, sensation seeking and impulsivity (Alfonso-Loeches and Guerri, 2011). Alcohol may therefore have a disproportionately greater

impact on the adolescent brain in contributing to disinhibition and aggression as important self-regulatory functions are still in the process of development and maturation.

Strengths and limitation

There are a number of limitations with our study. It was not possible to correct for all time-dynamic confounders and it is therefore possible that changes in the strength of the relationship over time can be explained by changes in confounders that varied over time, such as exposure to stress or trauma. Also, attrition in this study could have resulted in an over-estimation of the association between alcohol and violence if drinkers who became violent were less likely to drop out than drinkers who did not become violent, or if those who were non-drinkers who did not become violent were more likely to drop out. It is more likely however that those who were violent, and drinking alcohol were more likely to engage in other problematic or chaotic behaviours, and thus less likely to be traced or to participate in follow-up. It is possible therefore that, if anything, the extent of the relationships may be underestimated. In addition, all individuals who participated in two or more, not necessarily consecutive, waves of data collection were included in the study to maximise the information available, thus mitigating against non-participation in one or two waves.

We noted the sharp decline in reported violence between wave I and II which might be due to misclassification of violence at wave I (over reporting). However, similar findings were observed in the other measures of violence, fighting and fighting in a group, and neither were other forms of antisocial behaviour such as drug or alcohol use elevated among the first wave respondents as might be expected if there was a general tendency to over report deviant behaviours. It is unlikely therefore that there was substantial misclassification of violence at wave I. It is possible however that the perception of violence changed as participants got older, such that there was an under-reporting of violence as participants got older. Although the questions used to enquire about violence were identical at each wave, the perception of, or reporting of violence at different ages may have varied. For example the perpetration of violence as an adolescent categorised as *“hurting someone badly enough to need bandages or*

care from a doctor or nurse” may be more readily endorsed if both perpetrator and victim are young, for example if the victim receives medical attention from a school nurse, but at a later age, victims may not readily seek medical attention, such as in intimate partner violence. It is possible therefore that the relationship between alcohol and violence does not change with age, but the type of violence or perception of violence from the perspective of either perpetrator or victim changes. In addition, our focus was explicitly on physical violence, and our findings may not generalise to other forms of aggression such as sexual violence or aggression towards property. Nevertheless, our findings are in keeping with other longitudinal studies that indicate that the relationship between alcohol and violence holds for younger but not older age groups.

The main strengths of the study are the large size of the sample, which was representative of the US general population, the variation in age within the cohort, the variation in time between data collection points which allowed the application of appropriate statistical models to examine change, the long follow up period, good study retention rate, and the use of comparable measure at each time point.

An additional strength was the ability to control for a comprehensive set of potential confounders, including official rates of violent crime in the local community, and social indicators of the local area.

Conclusions

Our study provides evidence to support the hypothesis that the effect of alcohol on violence varies with quantity consumed on each occasion, and the effect of alcohol and violence appears to reduce with age. These findings suggest that efforts towards primary prevention of alcohol related violence reduction should be targeted on reducing the amount individuals consume on each occasion, and would best be focussed on adolescents.

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